

TOBIN

**Proposed Residential Development
Blackrock, Dundalk, Co. Louth
Flood Risk Assessment**

BUILT ON KNOWLEDGE

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1. INTRODUCTION

TOBIN were appointed by Westdalk (ROI) Ltd. to undertake a Flood Risk Assessment (FRA) for a proposed residential development at Blackrock, Dundalk, Co. Louth

Figure 1-1 shows the location of the subject site. The subject site is bounded to the north by a newly constructed residential estate. Greenfields and residential properties bound the site to the south, east and west, the Old Golfs Link Road is located to the south of the subject site.

The Planning System and Flood Risk Management (PSFRM) Guidelines categorise types of development into three vulnerability classes based on their sensitivity to flooding. As per Table 2-1 for the classification of vulnerability of different types of development in the PSFRM Guidelines, “residential properties” are categorized as “highly vulnerable” development and as such are considered appropriate in Flood Zone C (Low probability of flooding).

The hydraulic feature of particular interest to the subject site is the Blackrock Stream. The stream originates in its headwaters approximately 450m northwest of the subject site and flows in a southeasterly direction approximately 80m northeast of the subject site, before eventually draining into the sea approximately 1.2km south of the subject site.

Ground levels within the subject site range from approximately 10.5mOD at the southeast of the subject site to 11.4mOD at the northwest of the subject site, based on LIDAR data.

The purpose of this Stage 3 FRA report is to identify, quantify, and communicate the risks of flooding, if any, to the proposed development.



Figure 1-1: Site Location



The proposed development includes the construction of 4no 3-bed residential properties with private gardens and additional parking spaces, as shown in Figure 1-2,

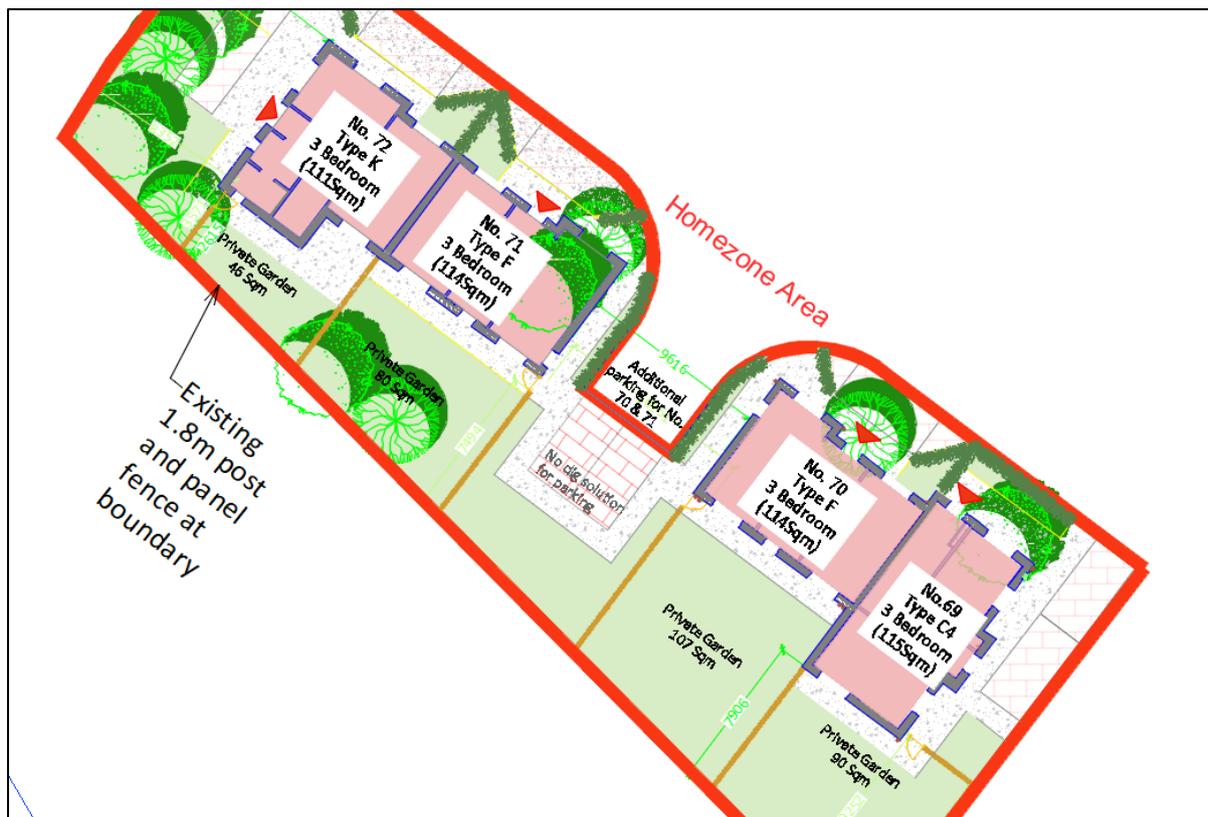


Figure 1-2: Site Layout



2. FLOOD RISK MANAGEMENT GUIDANCE

This Stage 3 Flood Risk Assessment was carried out in accordance with the following flood risk management guidance documents:

- The Planning System and Flood Risk Management Guidelines for Planning Authorities
- Flood Risk Management Climate Change Sectoral Adaptation Plan
- Louth County Development Plan (2021 – 2027)
- Dundalk Local Area Plan 2025-2031

2.1 THE PLANNING SYSTEM AND FLOOD RISK MANAGEMENT GUIDELINES

The Planning System and Flood Risk Management Guidelines for Planning Authorities (PSFRM Guidelines) were published in 2009 by the Office of Public Works (OPW) and Department of the Environment, Heritage, and Local Government (DoEHLG). Their aim is to ensure that flood risk is considered in development proposals and the assessment of planning applications.

2.1.1 Flood Zones and Vulnerability Classes

The PSFRM Guidelines discuss flood risk in terms of three flood zones (A, B, and C), which correspond to areas of high, medium, or low probability of flooding, respectively. The extents of each flood zone are based on the Annual Exceedance Probability (AEP) of various flood events.

The PSFRM Guidelines also categorise different types of development into three vulnerability classes based on their sensitivity to flooding. The guidelines classify residential properties as “highly vulnerable” and are therefore considered appropriate in Flood Zone C (less than 0.1% AEP).

Table 2-1 shows a decision matrix that indicates which types of development are appropriate in each flood zone and when the Justification Test (see Section 2.1.2) must be satisfied. The annual exceedance probabilities used to define each flood zone are also provided.

Table 2-1: Decision Matrix for Determining the Appropriateness of a Development

| Flood Zone: (Probability) | Annual Exceedance Probability (AEP) | Highly Vulnerable | Less Vulnerable | Water Compatible |
|------------------------------|---|-----------------------------------|-----------------------------------|---------------------|
| A (High) | <u>Coastal Flooding</u> More frequent than 0.5% AEP | Justification Test Required | Justification Test Required | Appropriate |
| | <u>Fluvial & Pluvial Flooding</u> More frequent than 1% AEP | | | |
| B (Medium) | <u>Coastal Flooding</u> 0.1% to 0.5% AEP | Justification Test Required | Appropriate | Appropriate |
| | <u>Fluvial & Pluvial Flooding</u> 0.1% to 1% AEP | | | |
| C (Low) | <u>Fluvial, Pluvial & Coastal Flooding</u> Less frequent than 0.1% AEP | Appropriate | Appropriate | Appropriate |



2.1.2 Justification Test

Any proposed development being considered in an inappropriate flood zone (as determined by Table 2-1) must satisfy the criteria of the Justification Test outlined in Figure 2-1 (taken from the PSFRM Guidelines).

Box 5.1 Justification Test for development management (to be submitted by the applicant)

When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied:

1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.
2. The proposal has been subject to an appropriate flood risk assessment that demonstrates:
 - (i) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;
 - (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;
 - (iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and
 - (iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

The acceptability or otherwise of levels of residual risk should be made with consideration of the type and foreseen use of the development and the local development context.

Note: See section 5.27 in relation to major development on zoned lands where sequential approach has not been applied in the operative development plan.

Refer to section 5.28 in relation to minor and infill developments.

Figure 2-1: Criteria of the Justification Test

2.2 THE FLOOD RISK MANAGEMENT CLIMATE ADAPTION PLAN

The Flood Risk Management Climate Change Sectoral Adaptation Plan was published in 2019 under the National Adaptation Framework and Climate Action Plan. This plan outlines the OPW’s approach to climate change adaptation in terms of flood risk management.

This approach is based on a current understanding of the potential impacts of climate change on flooding and flood risk. Research has shown that climate change is likely to worsen flooding through more extreme rainfall patterns, more severe river flows, and rising mean sea levels.

To account for these changes, the Adaptation Plan presents two future flood risk scenarios to consider when assessing flood risk:

- Mid-Range Future Scenario (MRFS)
- High-End Future Scenario (HEFS)

Table 2-2 indicates the allowances that should be added to estimates of extreme rainfall depths, peak flood flows, and mean sea levels for the future scenarios.

Table 2-2: Climate Change Adaptation Allowances for Future Flood Risk Scenarios

| Parameter | Mid-Range Future Scenario (MRFS) | High-End Future Scenario (HEFS) |
|-------------------------|----------------------------------|---------------------------------|
| Extreme Rainfall Depths | + 20% | + 30% |
| Peak River Flood Flows | + 20% | + 30% |
| Mean Sea Level Rise | + 0.5 m | + 1 m |

For the purpose of this flood risk assessment, the proposed development has been assessed against the Mid-Range Future Scenario as it represents a likely future scenario.



2.3 LOUTH COUNTY DEVELOPMENT PLAN (2021 – 2027)

The Current Louth County Development Plan¹ provides a strategic framework for planning and sustainable development in Co. Louth for 2021-2027.

The Louth County Development Plan (LCDP) for 2021-2027 was adopted by the Elected Members of Louth County Council on the 30th of September 2021.

Chapter 10 of the Development Plan outlines the plan for Utilities. Section 10-10 of the plan discusses Flood Risk Management for the county.

Flood Risk Policies for Louth County are as follows:

IU 26 To reduce the risk of new development being affected by possible future flooding by:

- Avoiding development in areas at risk of flooding and
- Where development in floodplains cannot be avoided, taking a sequential approach to flood risk management based on avoidance, reduction and adaptation to the risk.

IU 27 To ensure all proposals for development falling within Flood Zones A or B are consistent with the “The Planning System and Flood Risk Management – Guidelines for Planning Authorities” 2009. Proposals for development identified as being vulnerable to flooding must be supported by a site-specific Flood Risk Assessment and demonstrate to the satisfaction of the Planning Authority that the development and its infrastructure will avoid significant risks of flooding and not exacerbate flooding elsewhere.

In Flood Zone C, where the probability of flooding is low (less than 0.1%), site specific Flood Risk Assessment may be required and the developer should satisfy themselves that the probability of flooding is appropriate to the development being proposed.

The County Plan SFRA datasets and the most up to date CFRAM Programme climate scenario mapping should be consulted by prospective applicants for developments in this regard and will be made available to lower-tier Development Management processes in the Council.

Applications for development in flood vulnerable zones, including those at risk under the OPW’s Mid-Range Future Scenario, shall provide details of structural and non-structural risk management measures, such as those relating to floor levels, internal layout, flood-resilient construction, emergency response planning and access and egress during flood events.

IU 28 Where a site-specific Flood Risk Assessment demonstrates that there are significant residual flood risks to a proposed development or its occupiers in conflict with ‘The Planning System and Flood Risk Management – Guidelines for Planning Authorities’ 2009, planning permission will normally not be granted unless the requirements of Section 5.28 ‘Assessment of minor proposals in areas of flood risk’ can be satisfied.

IU 29 To implement the Flood Risk Management Measures as detailed in the Neagh Bann Flood Risk Management Plan, the Eastern Flood Risk Management Plan and the Dunleer Flood Risk Management Plan, ensuring that proposals for development support and do not impede the progression of these measures. Louth County Council will, in partnership with the Office of Public Works (OPW) deliver the following Flood Relief Schemes:

- Dundalk , Blackrock and Ardee;
- Drogheda and Baltray; and
- Carlingford and Greenore.

¹ <https://www.louthcoco.ie/en/publications/development-plans/louth-county-development-plan-2021-2027/volume-1-all.pdf>



- IU 30 To work with the Office for Public Works in the development and implementation of catchment-based strategies for the management of flood risk – including those relating to storage and conveyance.
- IU 31 To contribute towards the improvement and/or restoration of the natural flood risk management functions of flood plains subject to compliance with the environmental legislation and availability of resources.
- IU 32 To ensure each flood risk management activity is examined to determine actions required to embed and provide for effective climate change adaptation as set out in the OPW Climate Change Sectoral Adaptation Plan Flood Risk Management applicable at the time.
- IU 33 Where a portion of a site is at risk of flooding, the lands at risk will be subject to the sequential approach to ensure first and foremost that new development is directed towards lands at low risk of flooding; and to restrict the type of development to that ‘appropriate’ to each flood zone in accordance with Tables 3.1 and 3.2 of the Flood Risk Management Guidelines.
- IU 34 To consult with the Office of Public Works (OPW) in relation to proposed developments in the vicinity of drainage channels and rivers for which the OPW are responsible.
- IU 35 To consult with the Office of Public Works (OPW) in relation to proposed developments which include the construction, replacement or alteration of a bridge or culvert and to require that the developers obtain consent from the OPW under *Section 50 of the EU (Assessment and Management of Flood Risks) Regulations 2010 and Section 50 of the Arterial Drainage Act 1945, where appropriate.*



2.3.1 Louth County Strategic Flood Risk Assessment (SFRA)

The SFRA for County Louth and has been prepared in accordance with requirements of the Department of Housing, Local Government and Heritage and Office Public Works OPW Planning Guidelines, 'The Planning System and Flood Risk Management' (2009). The SFRA provides tools and methods to assist users in identifying the level of flood risk associated with an area to inform planning decisions. It supports the application of the sequential approach and provides data and maps to help in assessing sites against flood risk criteria. Where development is or would be at risk of flooding, it provides information on the mitigation measures considered deliverable to reduce the actual risk to that development and on the residual risks that would remain and how they might be managed.

The flood outline and flood mechanism for the subject site area in the SFRA is the same as in CFRAM. The subject site resides in majority in Flood Zone C, with portions of the subject site adjacent to the stream banks located within Flood Zones A and B.

The SFRA States that: *"Some lands within the Mount Avenue Masterplan area are inundated with Flood Zone A and B. As the development area is currently largely greenfield, the sequential approach of the Guidelines should be applied to ensure sustainable growth of Dundalk."*

Proposed - Flood Risk Management Measures:

Flood defences measures were proposed for Dundalk and Blackrock South AFA, as part of the OPW FRMP to provide protection for up to a 1 in 100-year fluvial event and also a 1 in 200-year coastal event. The preferred solutions are alternate routes for hard defences, combined with improvement of channel conveyance, which would provide the required standard of protection.

The SFRA's Flood Risk Summary for Dundalk:

Flood Risk Impact and Spatial Planning Integration

FRA's should be carried out in accordance with the Guidelines and the sequential approach for these sites to be developed in a sustainable manner and avoid flood risk. An assessment of climate and catchment changes shows Dundalk has been identified as being particularly susceptible to flooding from climate change scenarios. Future land use planning for the town should incorporate this into their FRA and development policies. Future development plans and flood risk assessments should consider the potential of climate change influence on flood extents in accordance with the Guidelines.



2.3.2 Dundalk and Ardee Flood Relief Scheme²

The focus of the Flood Relief Scheme (FRS) is Dundalk/Blackrock and Ardee which has been susceptible to past flooding in extreme events. These areas have also been identified as having a significant risk of flooding from future events. The FRS refers to the Neagh Bann CFRMP³ for the Dundalk proposed flood relief measures which will be subject to further development as part of scheme. Figure 2-2 below shows the subject site within the AFA boundary but is not contained within any identified Flood Cells.

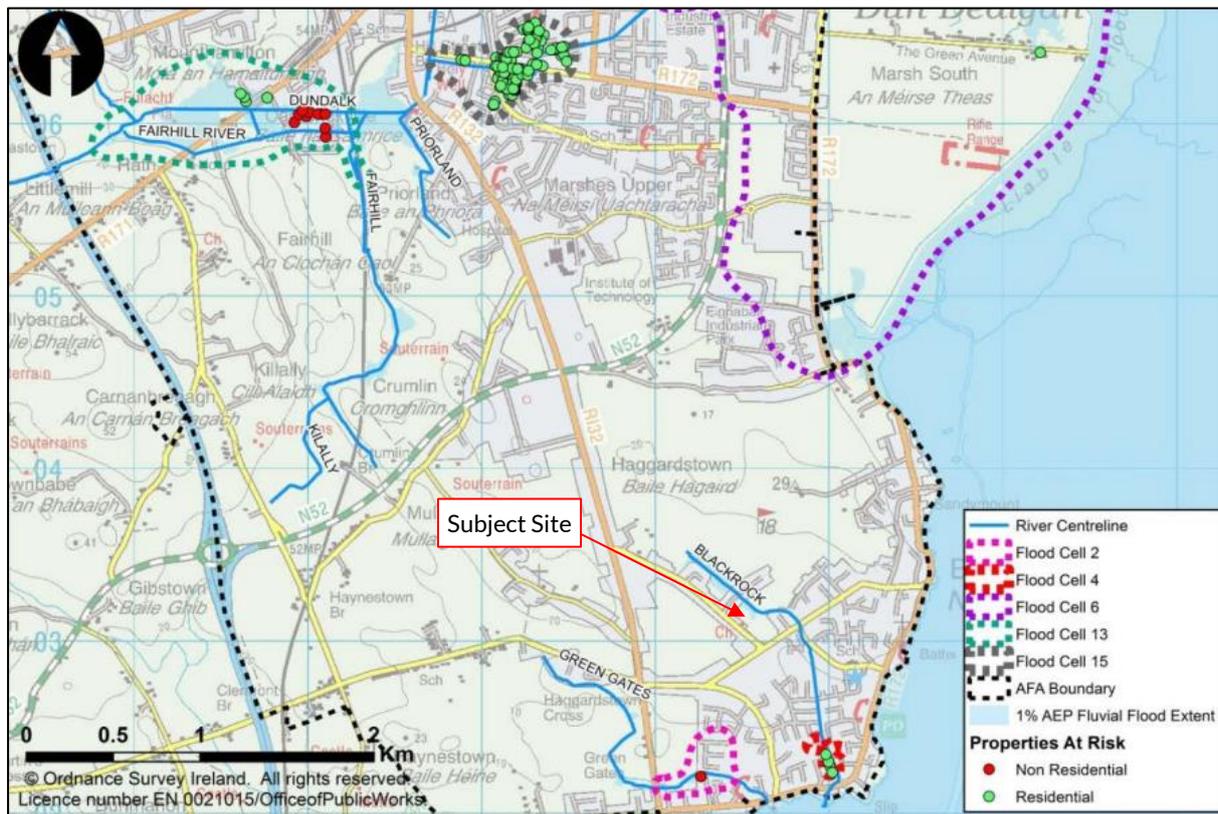


Figure 2-2: Dundalk and Blackrock South AFA Flood Cells with 1% AEP

² <https://www.floodinfo.ie/frs/en/dundalk/home/>

³ https://s3-eu-west-1.amazonaws.com/docs.floodinfo.opw/floodinfo_docs/NWNB_CFRAM/_UOM_06/06_PreliminaryOptions/IBE0700Rp0018_UoM06_Preliminary_Options_Report_F02_Merged.pdf



2.4 DUNDALK LOCAL AREA PLAN 2025 – 2031

The Dundalk Local Area Plan was adopted by the members at a Special Council Meeting on the 6th March 2025. The Plan comes into effect on the 17th of April 2025. Figure 2-3 below shows that the subject site is zoned as existing residential and is located in Flood Zone C.

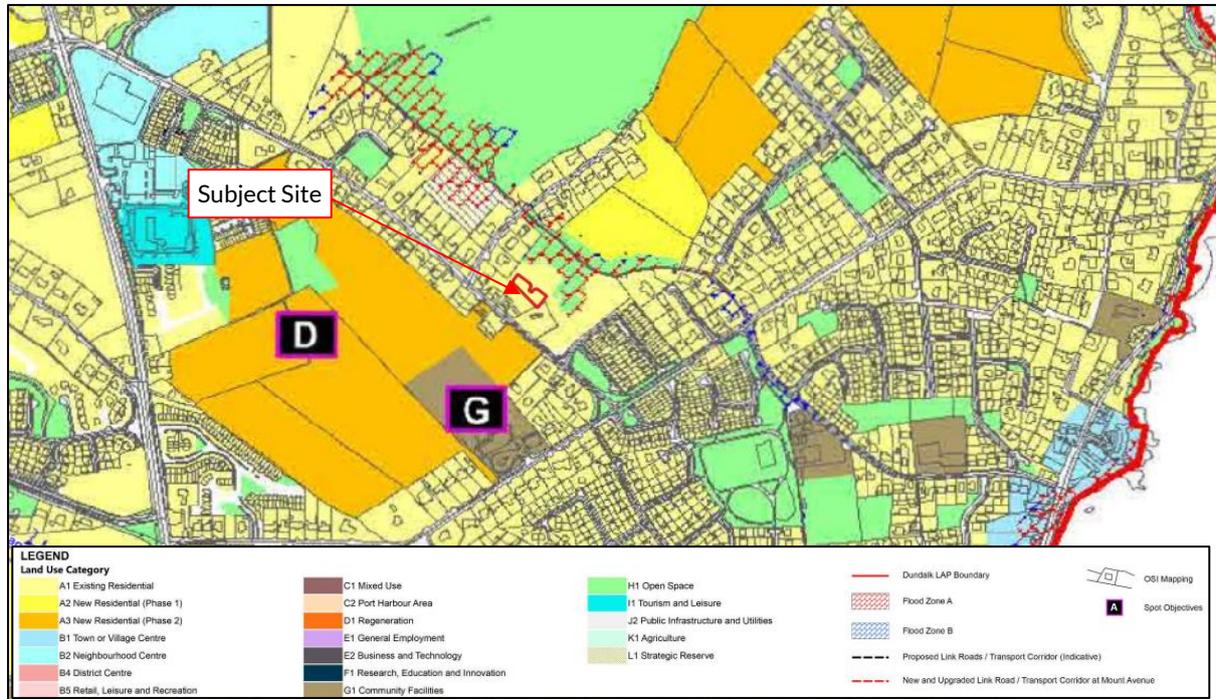


Figure 2-3: Dundalk Land Use and Flood Zoning



3. INITIAL FLOOD RISK ASSESSMENT

3.1 PAST FLOOD EVENTS

The OPW's National Flood Information Portal⁴ provides past flood event mapping with records of flooding reports, meeting minutes, photos, and/or hydrometric data. Based on the flood map shown in Figure 3-1, there are no historical flood events recorded within the vicinity of the subject site. The closest recorded flood event is located approximately 700m east of the subject site (Flood ID: 3271), occurring in 2002, as a result of coastal/estuarine waters.



Figure 3-1: Past Flood Events

⁴ floodinfo.ie



3.2 OPW PRELIMINARY FLOOD RISK ASSESSMENT (PFRA) STUDY

In 2009, the OPW produced a series of maps to assist in the development of a broad-scale FRA throughout Ireland. These maps were produced from several sources.

The OPW’s National Preliminary Flood Risk Assessment (PFRA) Overview Report from March 2012 noted that *“the flood extents shown on these maps are based on broad-scale simple analysis and may not be accurate for a specific location”*.

Figure 3-2 provides an overview of the fluvial, coastal, pluvial, and groundwater indicative flood extents in the vicinity of the subject site.

As per Figure 3-2, the subject site is not predicted to be liable to fluvial, coastal, pluvial, or groundwater flooding during extreme events.



Figure 3-2: Indicative Flood Mapping [extract from PFRA Map 324]





Figure 3-3: PFRA Flood Extents

The PFRA mapping indicates no areas of pluvial flooding within the subject site. The fluvial flood extents are seen to be approximately 800m southwest of the subject site on the Haggardstown stream. Based on the mapping it is expected that the Blackrock Stream was not modelled as part of the PFRA study.

Limitations on potential sources of error associated with the PFRA maps include:

- Assumed channel capacity (due to absence of channel survey information)
- Absence of flood defences and other drainage improvements and channel structures (bridges, weirs, culverts)
- Local errors in the national Digital Terrain Model (DTM)

Improved hydraulic modelling was carried out through the Catchment Flood Risk Assessment and Management Study (CFRAM) in 2015 (discussed in Section 3.4) and is considered more accurate than the PFRA study as it utilised surveyed river geometry and was subject to greater model calibration.

3.3 NATIONAL COASTAL FLOOD HAZARD MAPPING (NCFHM)

The National Coastal Flood Hazard Mapping (NCFHM) was completed in 2021. The aim of the project is to produce updated national scale coastal flood extent and depth maps for the 50%, 20%, 10%, 5%, 2%, 1%, 0.5% and 0.1% Annual Exceedance Probabilities (AEPs) for the present day scenario and for the Mid-Range Future Scenario (MRFS), High End Future Scenario (HEFS), High+ End Future Scenario (H+EFS) and High++ End Future Scenario (H++EFS) which represent a 0.5m, 1.0m, 1.5m and 2.0m increase in sea level respectively. The mapping is based on the extreme levels calculated in the Irish Coastal Wave and Water Level Modelling Study (ICWWS).

The Irish Coastal Wave and Water Level Modelling Study (ICWWS) was undertaken in 2018. The study provides an update to the Extreme Coastal Water Levels for the coastal of Ireland. The study provides an update to the water levels presented in the Irish Coastal Protection Strategy Study (ICPSS) undertaken between 2004 and 2013.⁵

Table 3-1 below outlines the extreme water levels at node NE4 which is the closest ICWWS node to the subject site. The node is approximately 2km southeast of the subject site

Table 3-1: ICWWS Modelled Extreme Water Levels

| Return Period | Existing Scenario Water Level (mOD) | Mid-Range Future Scenario (MRFS) Water Level (mOD) |
|----------------------------------|-------------------------------------|--|
| 1 in 100-Year (1% AEP) Event | 3.57 | 4.07 |
| 1 in 200-Year (0.5% AEP) Event | 3.64 | 4.14 |
| 1 in 1,000-Year (0.1% AEP) Event | 3.79 | 4.29 |

The NCFHM current flood extents are shown in Figure 3-4 below. The mapping shows that the subject site is not liable to coastal flooding in a 1 in 200-year (0.5% AEP) or 1 in 1000-year (0.1% AEP) Current event. The water levels in a 1 in 200- and 1 in 1000-year (0.5% and 0.1% AEP) current event are 3.64mOD and 3.79mOD respectively.

⁵Irish Coastal Wave and Water Level Modelling Study(ICWWS)
[Microsoft Word - IBE1505 ICWWS Ph1 Rp01 F02.docx](#)





Figure 3-4: NCFHM Current day flood extents

The NCFHM mid-range future scenario (MRFS) flood extents are shown in Figure 3-5 below. The mapping shows that again the subject site is not liable to flooding in a 1 in 200-year (0.5% AEP) or 1 in 1000-year (0.1% AEP) Current event. The water levels in a 1 in 200- and 1 in 1000-year (0.5% and 0.1% AEP) MRFS event are 4.14mOD and 4.29mOD respectively.





Figure 3-5: NCFHM MRFS flood extents



3.4 CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT STUDY

In 2015, the OPW produced flood maps as part of the Catchment Flood Risk Assessment and Management (CFRAM) Study. The flood extents in these maps are based on detailed modelling of Areas for Further Assessment identified by the National Preliminary Flood Risk Assessment.⁶

3.4.1 Fluvial Flood Risk (CFRAM)

CFRAM mapping of the existing fluvial flood extents, presented in Figure 3-6, indicates that the subject site is not liable to fluvial flooding from the Blackrock stream in a 1 in 100-year (1% AEP) or 1 in 1000-year (0.1% AEP) fluvial flood event. Accordingly, the entire subject site is located in Flood Zone C. Although the site is currently located in Flood Zone C based on the CFRAM mapping, a site-specific hydraulic model was created and will be discussed in Section 4 due to the uncertainty of the effect the new development north of the subject site will have on the flow paths from the river.

Ground levels within the subject site range from approximately 10.5mOD at the southeast of the subject site to 11.4mOD at the northwest of the subject site, based on LIDAR data.

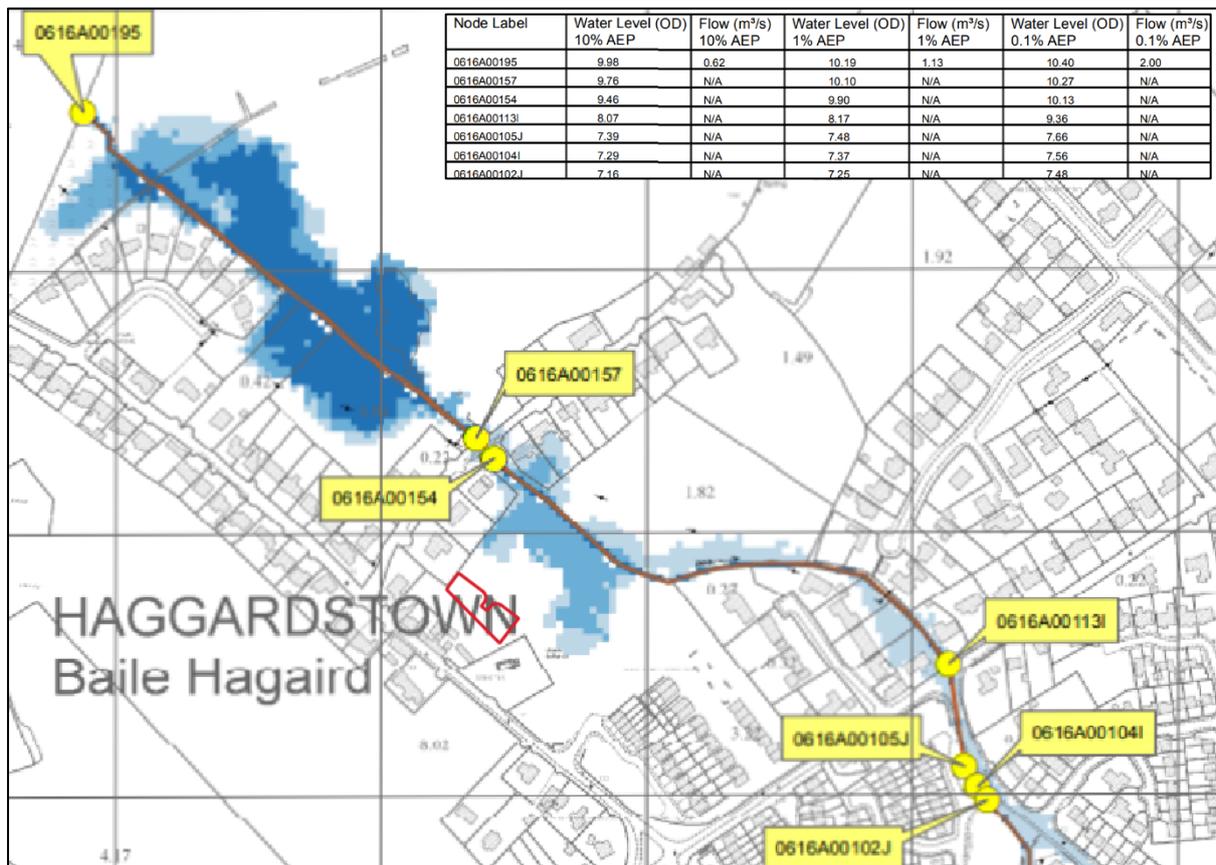


Figure 3-6: CFRAM Existing Fluvial Flood Extents (Extract from map: n06brk_exfcd_f0_03)

⁶ https://www.floodinfo.ie/about_frm/



Figure 3-7 shows the MRFS fluvial flood extents produced as part of the CFRAM study during the 1 in 100-year (1% AEP) and 1 in 1000-year (0.1% AEP) MRFS flood events. There is no large extent increase noted in the MRFS event, and again the subject site is not at risk of fluvial flooding.



Figure 3-7: CFRAM MRFS Fluvial Flood Extents



3.4.2 Coastal flood Risk (CFRAM)

Tidal flood mapping has been prepared for Dundalk through the Northwestern CFRAM Study and indicates that tidally influenced flooding does not affect the subject site.

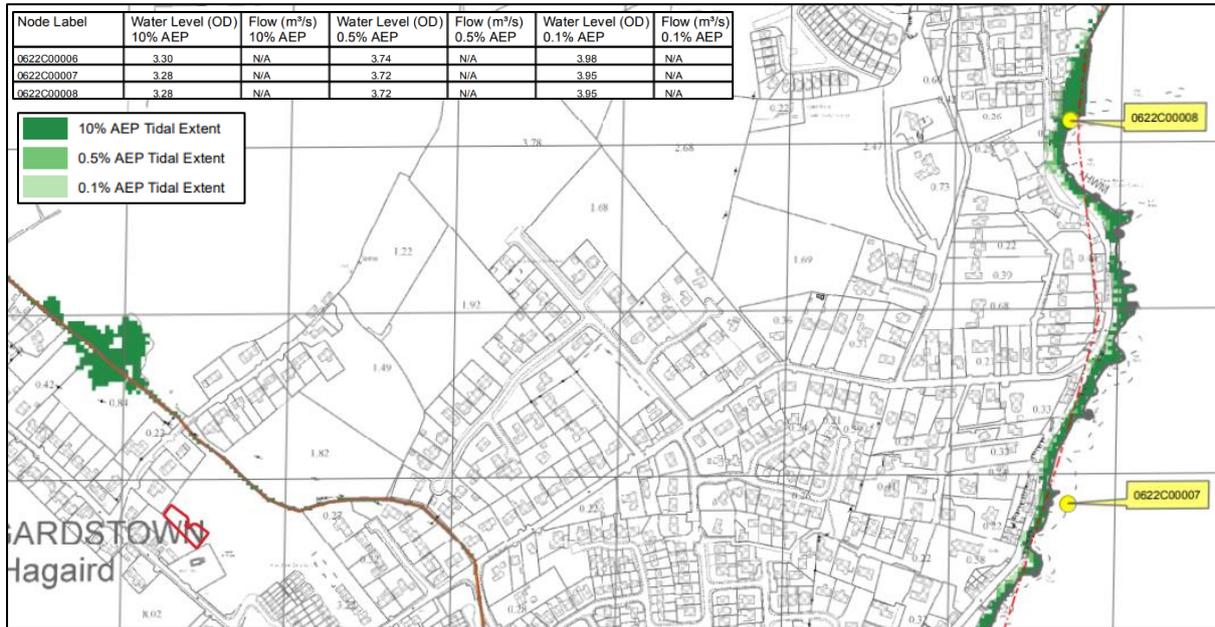


Figure 3-8: Northwestern CFRAM Current Tidal Flood Extents

The 1 in 1000-year (0.1% AEP) coastal water level at the node closest to the subject site (0622C00007) is 3.95mOD. The lowest ground level at the subject site is approximately 10.5mOD. The node is located approximately 1.05km east of the subject site.

Figure 3-9 shows the MRFS coastal flood extents produced as part of the CFRAM study during the 1 in 200-year (0.5% AEP) and 1 in 1000-year (0.1% AEP) MRFS flood events. There is no large extent increase noted in the MRFS event, and again the subject site is not at risk of coastal flooding.





Figure 3-9: CFRAM Current Tidal Flood Extents



3.5 OPW DRAINAGE DISTRICTS AND ARTERIAL DRAINAGE SCHEMES

The OPW Drainage Districts were carried out by the commissioners of Public Works under a number of drainage and navigation acts from 1842 to the 1930s to improve land for agriculture and to mitigate flooding.⁷ The local authorities are charged with the responsibility to maintain Drainage Districts.

Benefited lands are areas that were previously subject to poor drainage and/or flooding but that have benefited from the implementation of Arterial Drainage Schemes carried out under the Arterial Drainage Act 1945.

The subject site has not benefited from any arterial drainage scheme and is not located in a Drainage District.

⁷ www.floodinfo.ie



3.6 GEOLOGICAL SURVEY IRELAND MAPPING

Based on a review of the OPW’s Preliminary Flood Risk Assessment (PFRA) mapping (see Figure 3-2) there is no noted risk of groundwater flooding to the subject site.

GSI Groundwater Flooding Probability Maps⁸ for the subject site were reviewed. There are no groundwater flood extents in the vicinity of the subject site.



Figure 3-10: GSI Mapping of Groundwater Flooding

The closest surface water flooding is approximately 1.75km west of the subject site and is not expected to have any effect on the subject site’s hydrology.

Geological Survey Ireland (GSI) subsurface mapping of karst features⁹ in the area shows that there are no karst features located in the vicinity of the subject site (see Figure 3-11). There is a large cluster of karst features located approximately 20km west of the subject site, all of which are outside of the subject sites catchment area and therefore will not influence the subject sites hydrology.

⁸FloodInfo.ie | National Flood Information Portal, Available at: <https://www.floodinfo.ie/map/floodmaps/>

⁹GSI Groundwater Data Viewer, Available at: <https://dcnr.maps.arcgis.com/apps/webappviewer/index.html?id=7e8a202301594687ab14629a10b748ef>



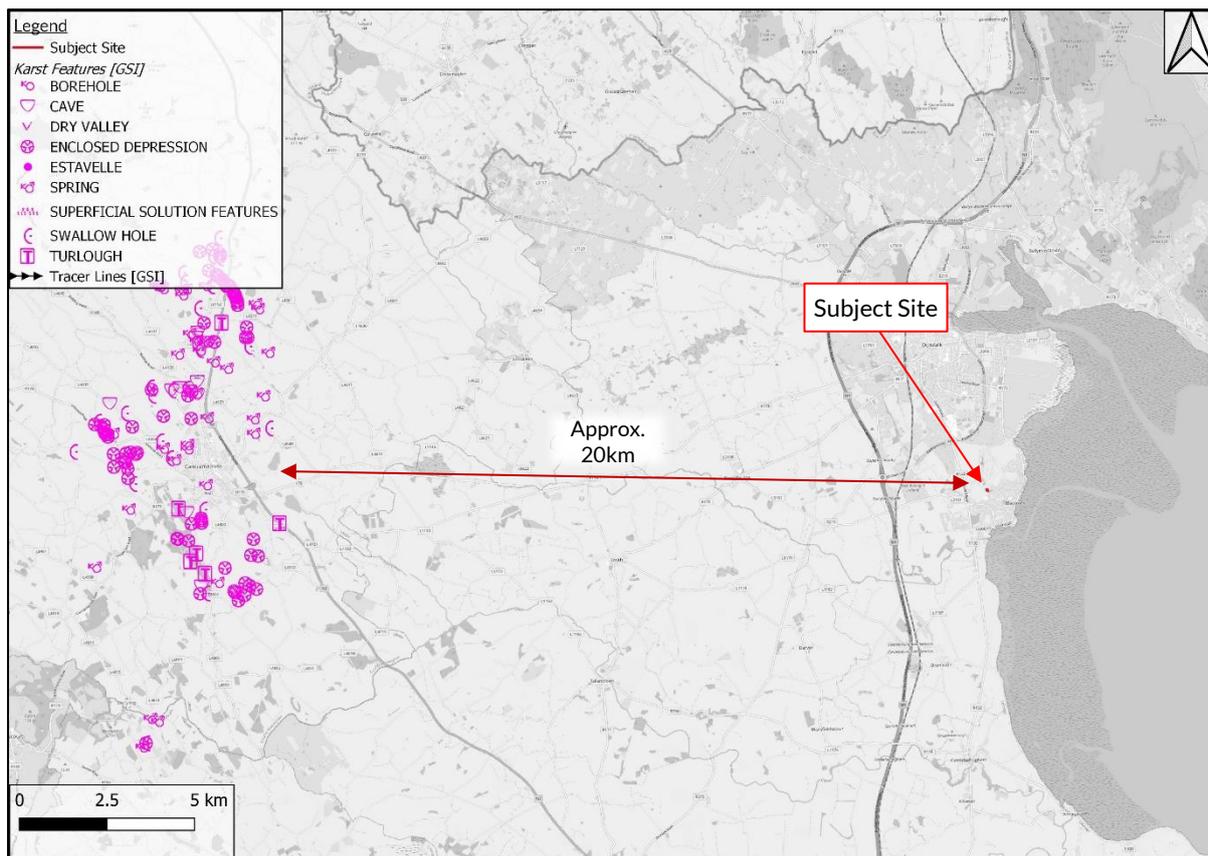


Figure 3-11: GSI Mapping of Karst Features



4. SITE SPECIFIC FLOOD RISK ANALYSIS

Due to the construction of a new housing estate to the north of the subject site, which restricts flow paths in the flood plain, and the refurbishment of the stream as part of the development, a site specific hydrology and hydraulic assessment of the Blackrock stream was required to quantify flood level/extents and ensure that the new river channel and development do not increase the risk of flooding to the subject site.

4.1 HYDROLOGY FLOW ESTIMATION

The Blackrock stream flows approximately 80m northeast of the subject site, with its headwaters located approximately 450m northwest of the subject site.

The stream's catchment area for the subject site was calculated using high-resolution LiDAR data. Flow paths were delineated based on this data, and these flow paths were used to define the area of flow influencing the subject site.

The catchment area for the stream at the subject site was estimated at 1.386km² based on the above methodology. See the flow paths and delineated catchment based on these flow paths in Figure 4-1 below



Figure 4-1: Catchment Delineation

Given the size of the catchment. The Institute of Hydrology Report No. 124 (IH124) methodology was deemed suitable to estimate flood flows at the subject site. The IH124 methodology, developed by D.C.W. Marshall and A.C. Bayliss from the Institute of Hydrology, is

specifically designed for use on catchments between 0.4 and 25km². Extreme flows within the catchment were estimated based on the catchment descriptors in Table 4-1.

Table 4-1: Summary of Catchment Descriptors

| Descriptor | Units | Value | Source |
|-------------------|-----------------|-------------------------|-----------|
| Watercourse | - | Blackrock Stream | EPA |
| Catchment Area | km ² | 1.386 | FSU/TOBIN |
| FEH | | YES | FEH |
| IH124 | - | YES | IHI24 |
| SAAR | mm | 843 | FSU/MET |
| S1 | | 0 | WRAP |
| S2 | | 1 | WRAP |
| S3 | | 0 | WRAP |
| S4 | | 0 | WRAP |
| S5 | | 0 | WRAP |
| i ₁₀ | mm/hr | 17.10 | MET |
| i ₁₀₀ | mm/hr | 28.40 | MET |
| i ₁₀₀₀ | mm/hr | 43.64 | MET |
| CWI | - | 118 | graph |
| URBAN | fraction | 0.4 | user |
| UCWI (winter) | - | 139 | graph |

Growth factors were applied to the estimation of Q_{bar} to predict the 1 in 100-year and 1 in 1000-year flows, respectively.

In accordance with the Climate Change Sectorial Adaption Plan, the proposed development was assessed against a Mid-Range-Future-Scenario (MRFS) which includes a 20% increase in flow.

The largest flows from each methodology were compared, and the largest was conservatively adopted as the design flow

Table 4-2: Estimated Flows

| Description | Units | Blackrock Stream (IH124) |
|----------------------------|------------------------|--------------------------|
| 100-year Flow | m ³ /s | 0.97 |
| 100-year MRFS Flow | m³/s | 1.16 |
| 1000-year Flow | m ³ /s | 1.23 |
| 1000-year MRFS Flow | m³/s | 1.48 |



4.2 HYDRAULIC MODEL CONSTRUCTION

A 1D/2D site-specific hydraulic model of the site area was developed using the latest version (6.2) of Jacob's Flood Modeller software. Flood Modeller is designed to perform combined one dimensional and two-dimensional hydraulic calculations for a full network of natural and constructed channels. The three primary inputs into the Flood Modeller model are summarised below:

- Geometric Data: Cross-sectional survey of watercourse, culverts and bridges
- Inflow Data: 1 in 100-year and 1 in 1000-year existing and MRFS design flows
- Downstream Boundary Condition: Normal depth based on downstream sections

The upstream boundary condition was defined using a flow hydrograph to accurately represent the inflow conditions. A uniform hydrograph with a 3-hour duration (calculated using the formula $T_c = 0.76AREA^{0.38}$, which is used to estimate the time of concentration for a catchment area). The hydrograph was set to peak at 1 and this hydrograph was then multiplied by the flow values presented in Table 4-2. The inflow hydrograph is shown in Figure 4-2 below

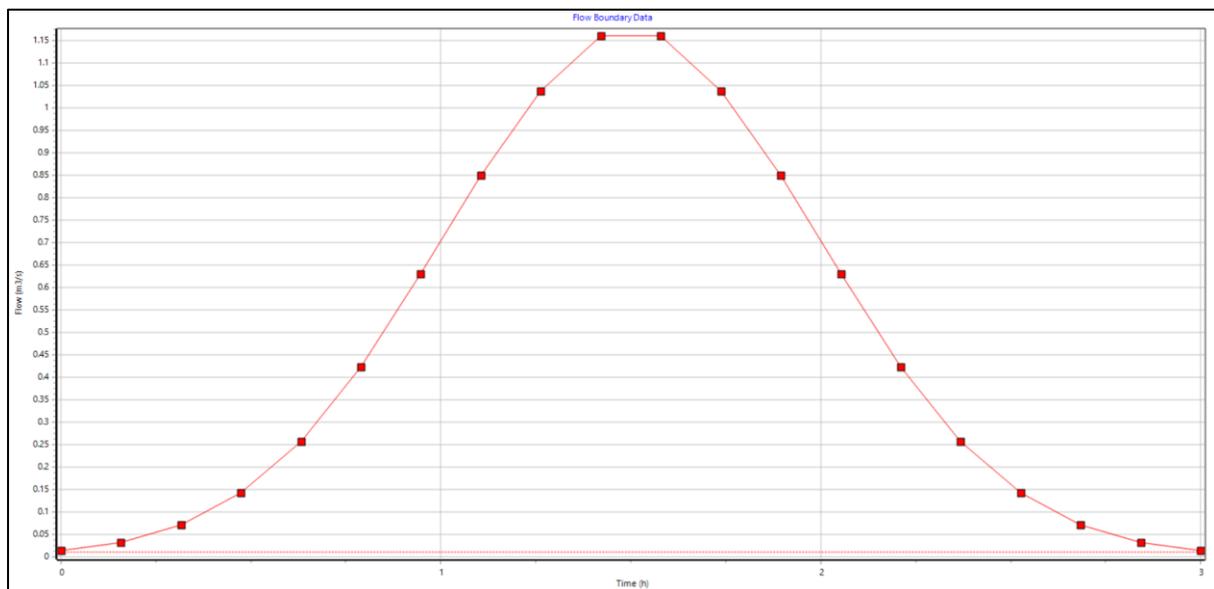


Figure 4-2: Inflow Hydrograph

The Normal Depth Downstream Boundary condition was calculated to be 0.0029851, based on the average downstream gradient of the stream along the modelled reach.

In accordance with the Climate Change Sectorial Adaptation Plan, the proposed development was assessed against a Mid-Range-Future-Scenario (MRFS) which includes a 20% increase in flow. The model applied a 1D/2D approach, applying a 2m grid size to represent the out of bank flows within the model domain. A conservative roughness value of 0.05 was applied to the flood plain based on site photography. Due to the recently constructed housing estate to the north of the subject site and the unavailability of an updated Digital Terrain Model (DTM), the block of houses to the north of the subject site was input into the model as a polygon with a set height to restrict the flow of water through the houses and more accurately represent the flow paths.

A key input into a 1D/2D hydraulic model is the grid size of the 2D domain. This is determined by the level of detail required to pick up local hydraulic features and topography. For larger hydraulic models, the grid sizes of the 2D domain typically range from 5m to 20m. Smaller grid sizes are typically used in urbanised areas or small scale site-specific hydraulic models as they



are better at capturing localised features. The CFRAM model used a 5m grid size for this area. TOBIN has applied a 2m grid size for this site-specific model. The smaller grid size was used given the study area and the size of the proposed features. A 5m grid size would not accurately capture the affect the proposed development would have on the modelled floodplain. The 2m grid sizing provides a better representation of the flow paths around the subject site.

Figure 4-3 below outlines the model configuration.

The model was used to run four unsteady flow scenarios: the 100 and 1 in 1000-year flood events with and without climate change, as previously shown in Table 4-2. These events were simulated over a 3-hour duration with a fixed 1 second timestep. The results of the hydraulic modelling are given in Section 4.3.

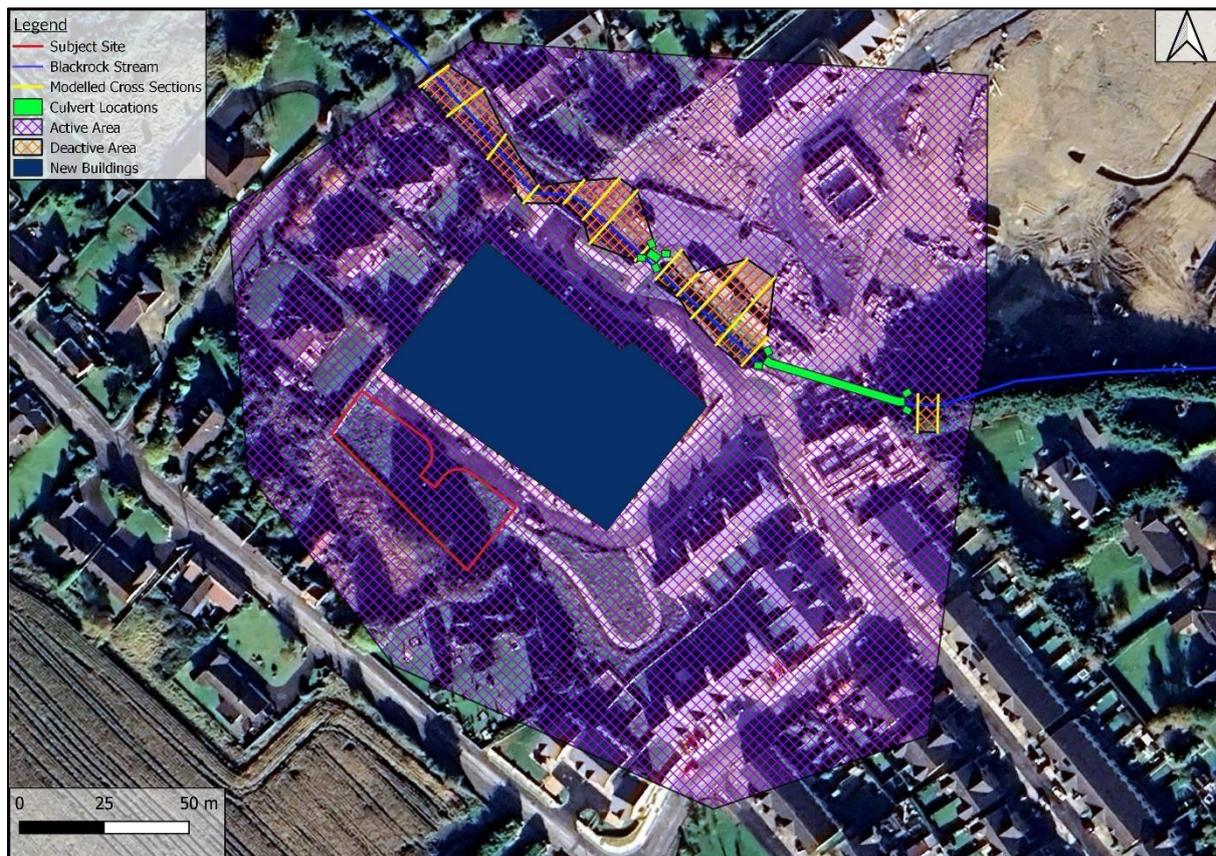


Figure 4-3: Model Configuration



4.3 HYDRAULIC MODEL RESULTS

The Blackrock stream was initially modelled due to the new residential development located to the north of the subject site, which restricts flow paths, and the stream was refurbished as part of the development, therefore modelling was necessary to assess the effects the development had on the streams flood extents.

The model has been simulated for four scenarios namely the 1 in 100-year (1% AEP) and 1 in 1000-year (0.1% AEP) for both the current and Mid-Range Future Scenarios (MRFS).

Figure 4-4 outlines the modelled flood extents for the 1 in 100-year (1% AEP) and 1 in 1000-year (0.1% AEP) current flood event. The subject site however is not liable to fluvial flooding in the 1 in 100-year (1% AEP) or 1 in 1000-year (0.1% AEP) current events. Therefore, based on the TOBIN model, the entire subject site is located in Flood Zone C.

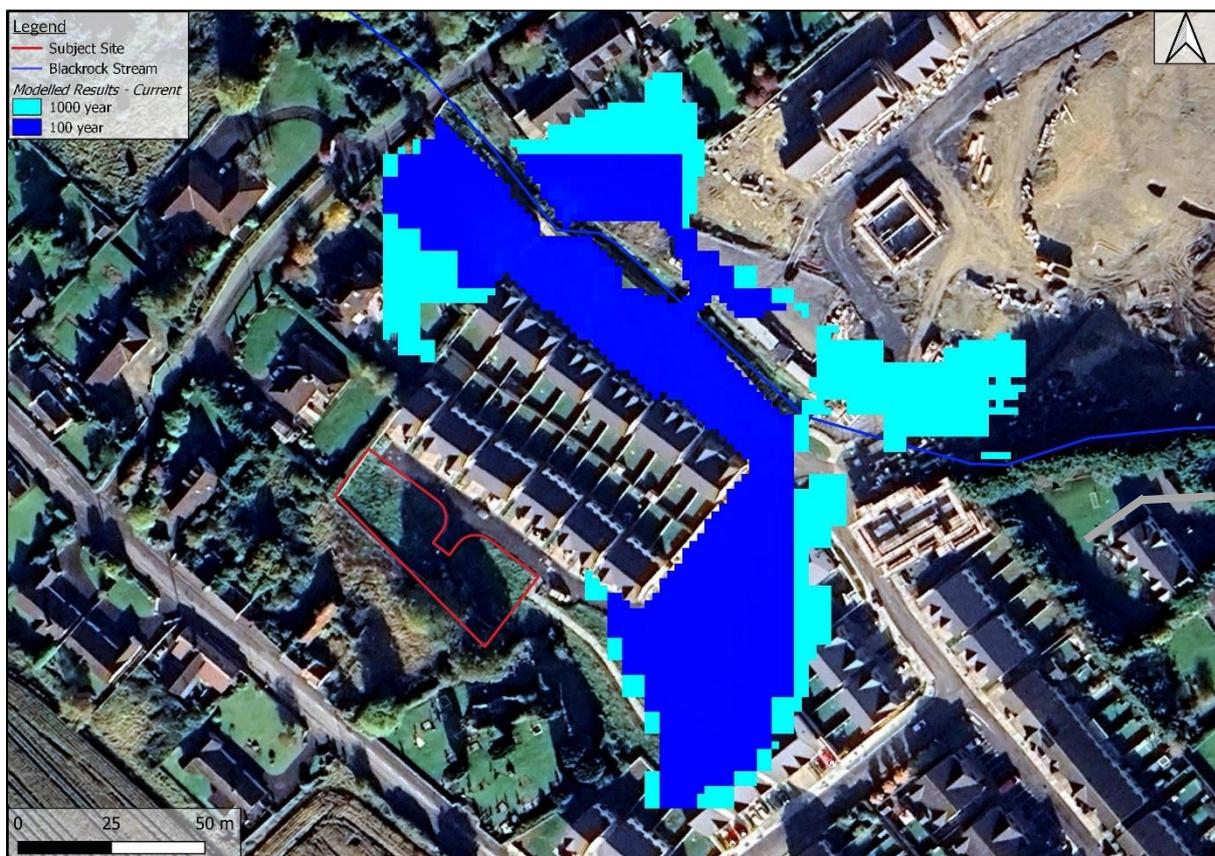


Figure 4-4: Modelled Results (Current 1 in 100-year & 1 in 1000-year)

In accordance with the Climate Change Sectorial Adaption Plan, the proposed development was assessed against a Mid-Range-Future-Scenario (MRFS) which includes a 20% increase in flow.

Figure 4-5 shows the 100- and 1000-year MRFS flood extents estimated in the vicinity of the subject site using the hydraulic model. Again, the subject site is not shown to be at risk of fluvial flooding from the Blackrock Stream.



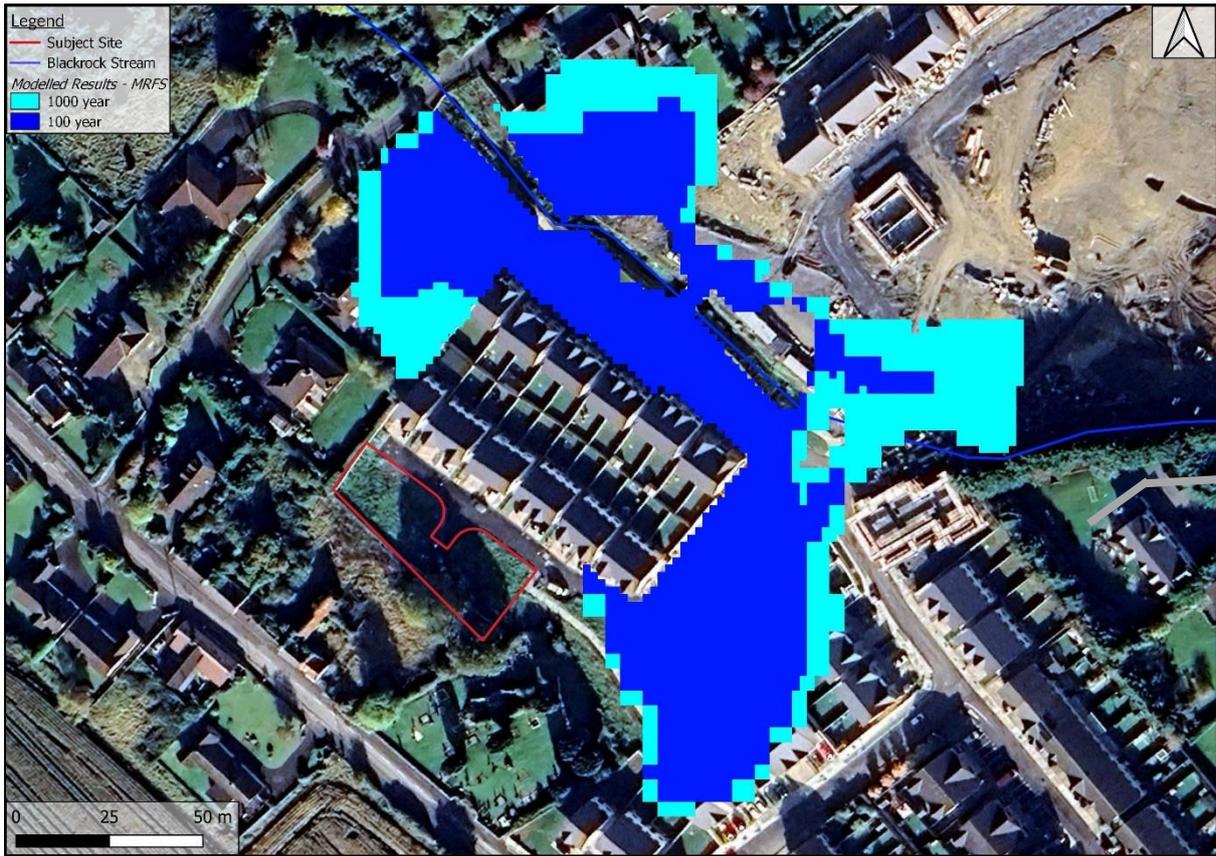


Figure 4-5: Modelled Results (MRFS 1 in 100-year & 1 in 1000-year)



4.4 HYDRAULIC MODEL SENSITIVITY ANALYSIS

A sensitivity analysis was conducted on the hydraulic model to evaluate the impact of varying Manning's roughness coefficients on the model's performance. Three different roughness values were tested: 0.03, 0.05, and 0.07. The results indicated that there was very little difference in the model outputs across these three roughness values. Given the minimal variation observed, a roughness coefficient of 0.05 was selected for the final model. This value was chosen as it is more conservative than 0.07, providing a balance between accuracy and safety, without being as extreme as 0.03. The results of the sensitivity analysis are shown in Figure 4-6.

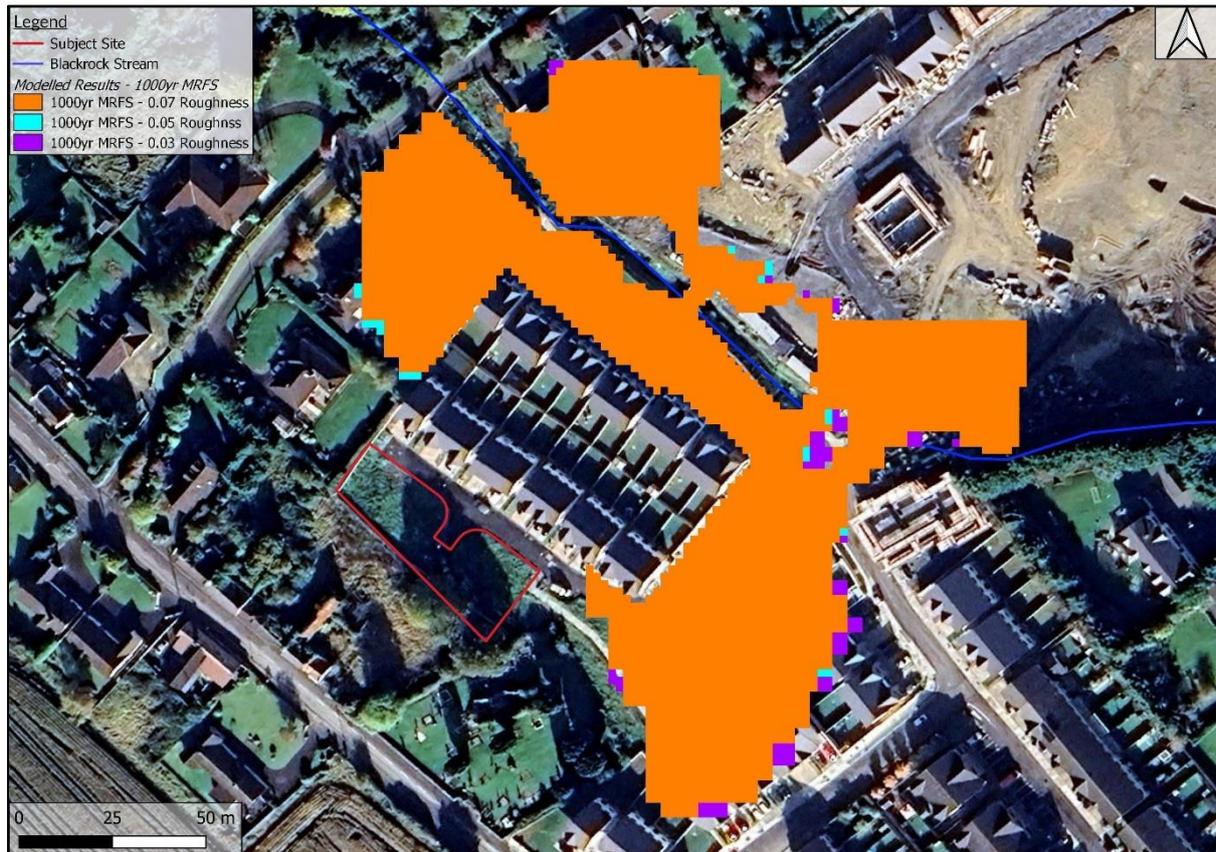


Figure 4-6: Modelled Results Sensitivity Analysis

A blockage scenario for either bridge was ruled out due to the presence of trash screens at the upper end of the bridges, which effectively prevent debris accumulation and blockages.

Figure 4-7 shows one of the existing trash screens at the bridges along the Blackrock Stream.





Figure 4-7: Trash Screens at Upstream Face of Bridges

5. DETAILED FLOOD RISK ASSESMENT

With reference to the PSFRM guidelines, the proposed development is comprised of 'highly vulnerable' (residential properties) elements.

Therefore, residential properties are considered appropriate in Flood Zone C (Low probability of flooding i.e., 0.1% AEP).

5.1 FLUVIAL FLOODING

The subject site is located 80m southeast of the Blackrock Stream, which heightens its risk of fluvial flooding due to the small distance between the site and the stream.

Due to the construction of a residential development to the north of the subject site, which restricts flow paths, and the fact that the development involved the refurbishment and altering of the Blackrock stream, a site-specific hydraulic model of the Blackrock Stream was carried out to quantify flood extents locally, and to assess the impact of the development (if any) on the floodplain storage and flood risk elsewhere.

TOBIN's site-specific hydraulic model, which superseded the CFRAM study, showed that the subject site is not liable to fluvial flooding in a 1 in 100-year (1% AEP) or 1 in 1000-year (0.1% AEP) current or MRFS event. This, therefore, locates the entire subject site in Flood Zone C, which is an appropriate Flood Zone for Residential developments.

The 1 in 1000-year (0.1% AEP) MRFS water level at the flood extents closest point to the subject site is 10.33mOD, therefore it is recommended that the development be constructed to a minimum FFL of 10.63mOD, to allow for 300mm of freeboard above the 1 in 1000-year (0.1% AEP) extents.

Therefore, provided the minimum floor level is adhered to, it is estimated that the fluvial flood risk to the proposed residential development will be minimal and will not increase the risk of flooding elsewhere.

5.2 COASTAL FLOODING

Based on a review of available mapping, it is estimated that there is no coastal flood risk to the subject site. NCFHM mapping, which supersedes the CFRAM, indicates no coastal flooding to the subject site in a 1 in 1000-year (0.1% AEP) Current or MRFS event. The ICWWS coastal water levels in the 1 in 1000-year (0.1% AEP) MRFS event are 4.29mOD. The minimum ground level at the subject site is approximately 10.5mOD, therefore providing over 6.2m of freeboard above the 1 in 1000-year (0.1% AEP) MRFS event.

Therefore, the risk of coastal flooding to the subject site is minimal.



5.3 PLUVIAL FLOODING

The PFRA indicative mapping indicates that the subject site is not at risk of pluvial flooding.

Surface water arising on the proposed mixed-use development will be managed by a dedicated stormwater drainage system in accordance with Sustainable Drainage Systems (SuDS) principles, limiting discharge from the site to greenfield runoff rates.

The landscaping and topography of the developed site will provide safe exceedance flow paths and prevent surface water ponding to minimise residual risks associated with an extreme flood event or a scenario where the stormwater drainage system becomes blocked.

Therefore, it is estimated that risk of pluvial flooding associated with the proposed development is minimal.

5.4 GROUNDWATER FLOODING

Based on a review of Geological Survey Ireland (GSI) subsurface mapping of karst features (Figure 3-11), predicted groundwater flooding in the area (Figure 3-10), and the PFRA study (Figure 3-2), there is no evidence to suggest liability to groundwater flooding at the proposed development site.

5.5 THE JUSTIFICATION TEST

The PSFRM Guidelines classify residential developments as “highly vulnerable”, in terms of sensitivity to flooding. Such developments are considered appropriate in Flood Zone C—where there is less than a 0.1% Annual Exceedance Probability (AEP) of flooding.

Based on the result of site-specific hydraulic analysis it is estimated that all proposed residential is appropriately located within Flood Zone C. The Justification Test therefore does not apply.



6. CONCLUSIONS

TOBIN was appointed by Westdalk (ROI) Ltd to carry out a Stage 3 FRA for a proposed residential development at Blackrock, Dundalk, Co. Louth

With reference to the PSFRM guidelines, the proposed development is comprised of “highly vulnerable” (residential properties).

Fluvial Flooding

TOBIN’s site-specific hydraulic model, which superseded the CFRAM study, showed that the subject site is not liable to fluvial flooding in a 1 in 100-year (1% AEP) or 1 in 1000-year (0.1% AEP) current or MRFS event. This, therefore, locates the entire subject site in Flood Zone C, which is an appropriate Flood Zone for Residential developments.

The 1 in 1000-year (0.1% AEP) MRFS water level at the flood extents closest point to the subject site is 10.33mOD, therefore it is recommended that the development be constructed to a minimum FFL of 10.63mOD, to allow for 300mm of freeboard above the 1 in 1000-year (0.1% AEP) extents.

Based on the findings of this FRA, the proposed development is appropriately located within Flood Zone C. and provided the recommended FFL is adhered to, It is estimated that the risk of fluvial flooding associated with the development is minimal.

Coastal Flooding

NCFHM mapping indicates no coastal flooding to the subject site in a 1 in 1000-year (0.1% AEP) current or MRFS event. The ICWWS coastal water levels in the 1 in 1000-year (0.1% AEP) MRFS event are 4.29mOD. The minimum ground level at the subject site is approximately 10.5mOD, therefore providing over 6.2m of freeboard above the 1 in 1000-year (0.1% AEP) MRFS event.

Therefore, the risk of coastal flooding to the subject site is minimal.

Pluvial Flooding

Pluvial mapping was published as part of PFRA mapping and indicated that the subject site is not liable to pluvial flooding.

Surface water arising on the proposed mixed-use development will be managed by a dedicated stormwater drainage system in accordance with Sustainable Drainage Systems (SuDS) principles, limiting discharge from the site to greenfield runoff rates.

The landscaping and topography of the developed site will provide safe exceedance flow paths and prevent surface water ponding to minimise residual risks associated with an extreme flood event or a scenario where the stormwater drainage system becomes blocked.

Therefore, the risk of pluvial flooding to the subject site is minimal.

Groundwater Flooding

There is no evidence to suggest groundwater as a potential source of flood risk to the proposed subject site.



Based on the results of this flood risk assessment, it is estimated that the risk of flooding to the proposed development will be minimal, and that the development will not increase the risk of flooding elsewhere, all residential properties are appropriately located in Flood Zone C.



Appendix A SITE LAYOUT



